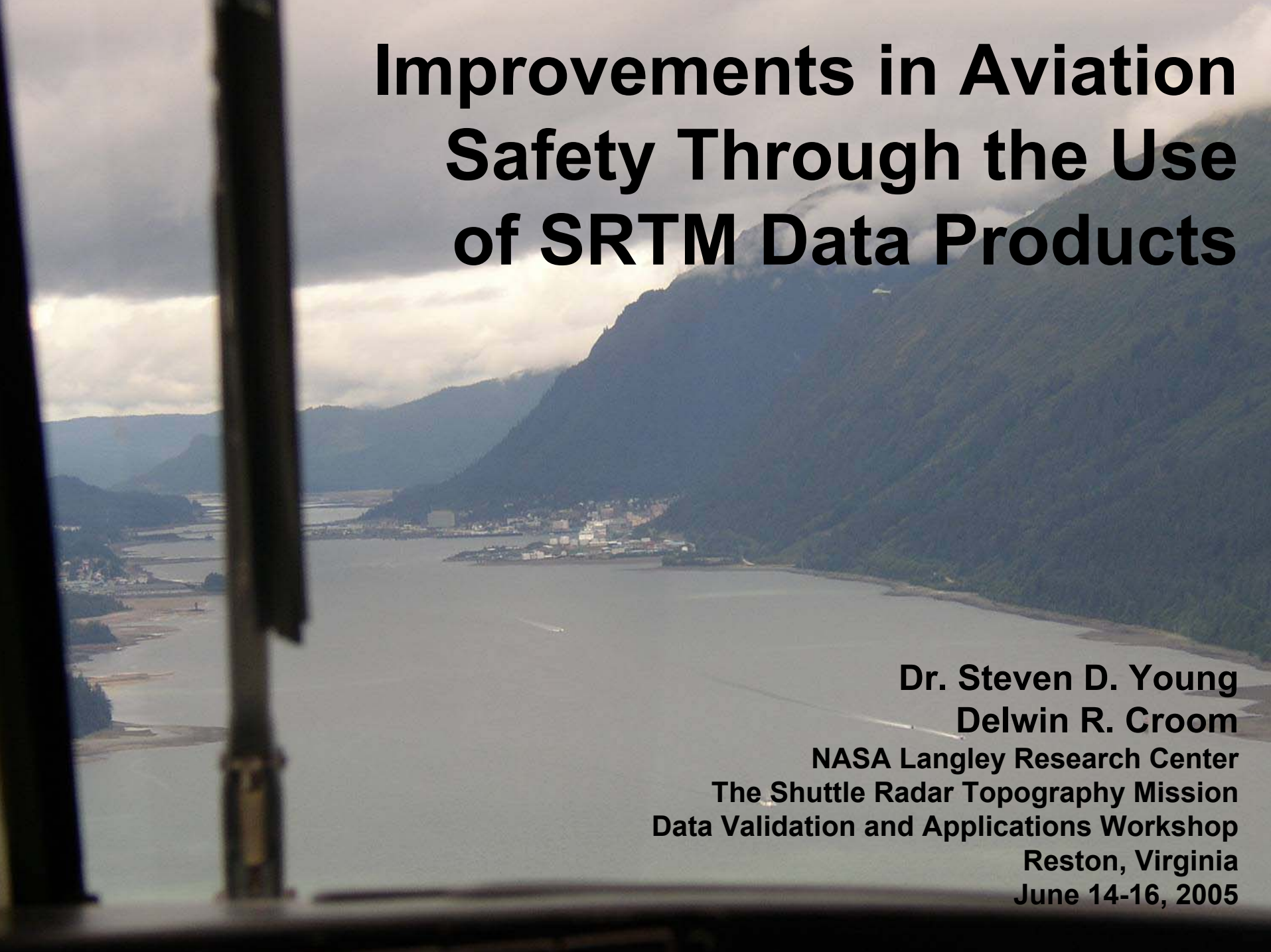


Improvements in Aviation Safety Through the Use of SRTM Data Products

Dr. Steven D. Young
Delwin R. Croom
NASA Langley Research Center
The Shuttle Radar Topography Mission
Data Validation and Applications Workshop
Reston, Virginia
June 14-16, 2005

Topics

: Aviation Safety

: Synthetic Vision Systems

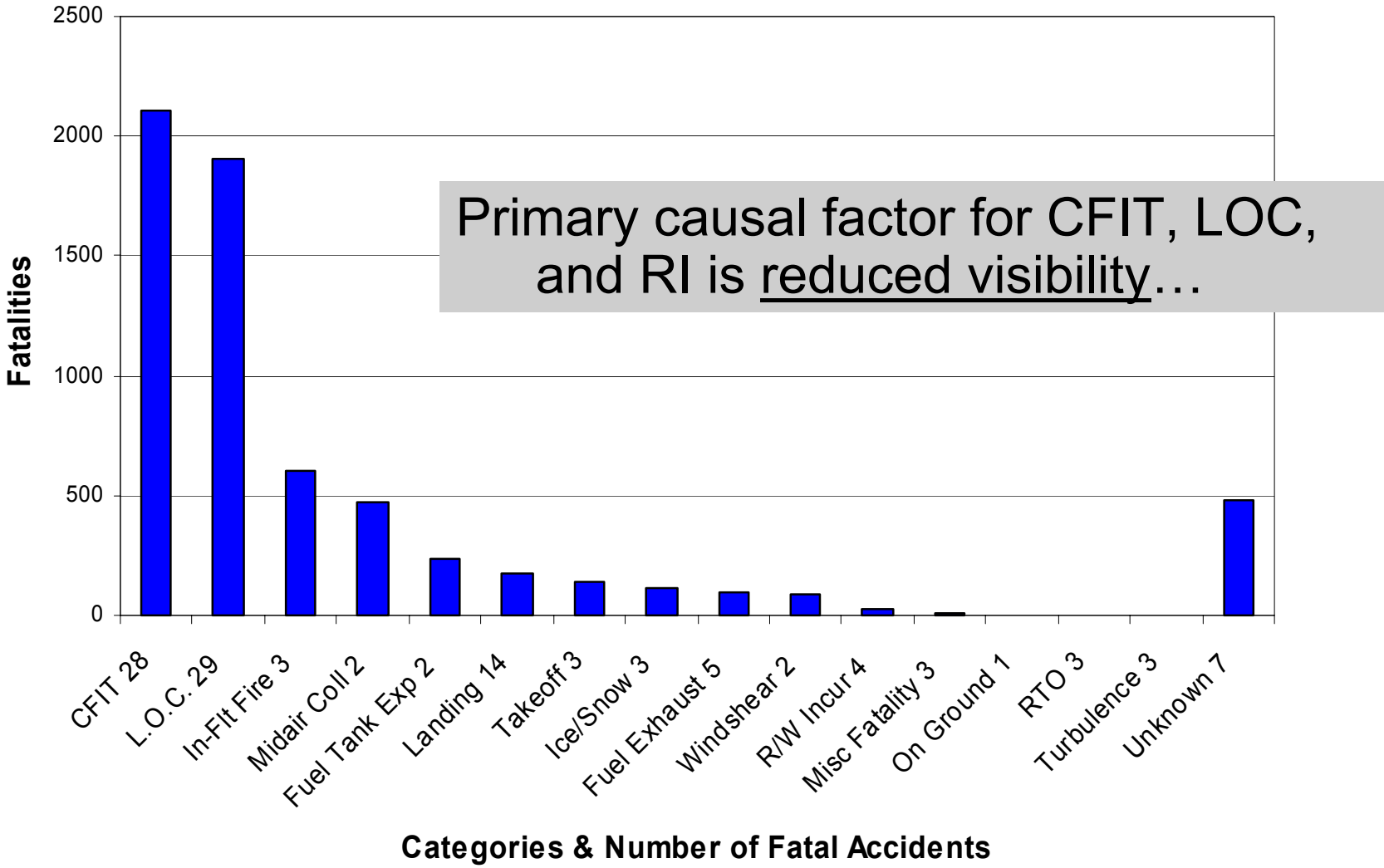
: Aeronautical Database Standards

: SRTM Data Product Applicability

: Data Integrity

: Summary

Aviation Safety



Primary causal factor for CFIT, LOC, and RI is reduced visibility…

*Ref: Boeing data (1990-1999)

Air China Boeing 767-200, April 15 2002

Pusan, South Korea
128 fatalities, 39 survivors including a pilot

CONTROLLED FLIGHT INTO TERRAIN (CFIT)
Air China flight 129 ploughed into a 1,000 ft ***mountain*** as it was preparing to land in ***heavy fog and rain.*** The pilot stated that he "felt ***no plane malfunction*** before the crash“.

Near Martha's Vineyard July 16, 1999

Piper Saratoga PA-32R-301
3 fatalities

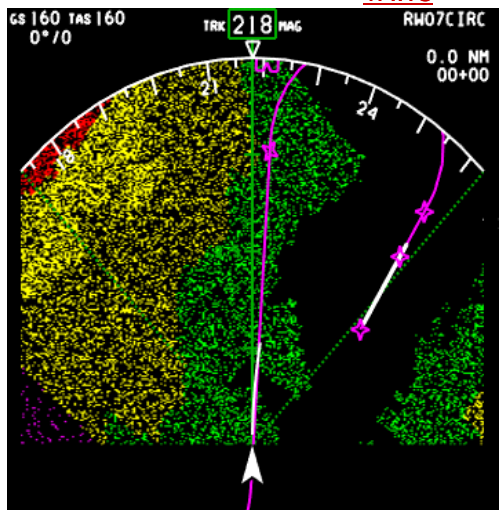
LOSS OF HORIZON

The low-time non-instrument rated pilot departed at night in VFR conditions. Cause of the accident was determined to be the pilot's ***failure to maintain control*** during descent over water at night; the result of ***spatial disorientation***. Factors in the accident were haze and the dark night.

Geospatial Data in Aviation*

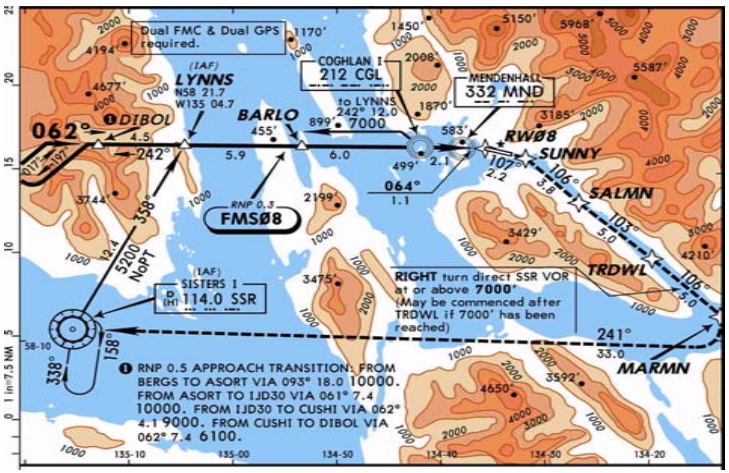
: Cockpit-based Applications

- Terrain Awareness and Warning Systems (TAWS)
- Off-airway “drift-down” protection
- Emergency landing site location selection
- Synthetic Vision Systems (SVS)



: Ground-based Applications

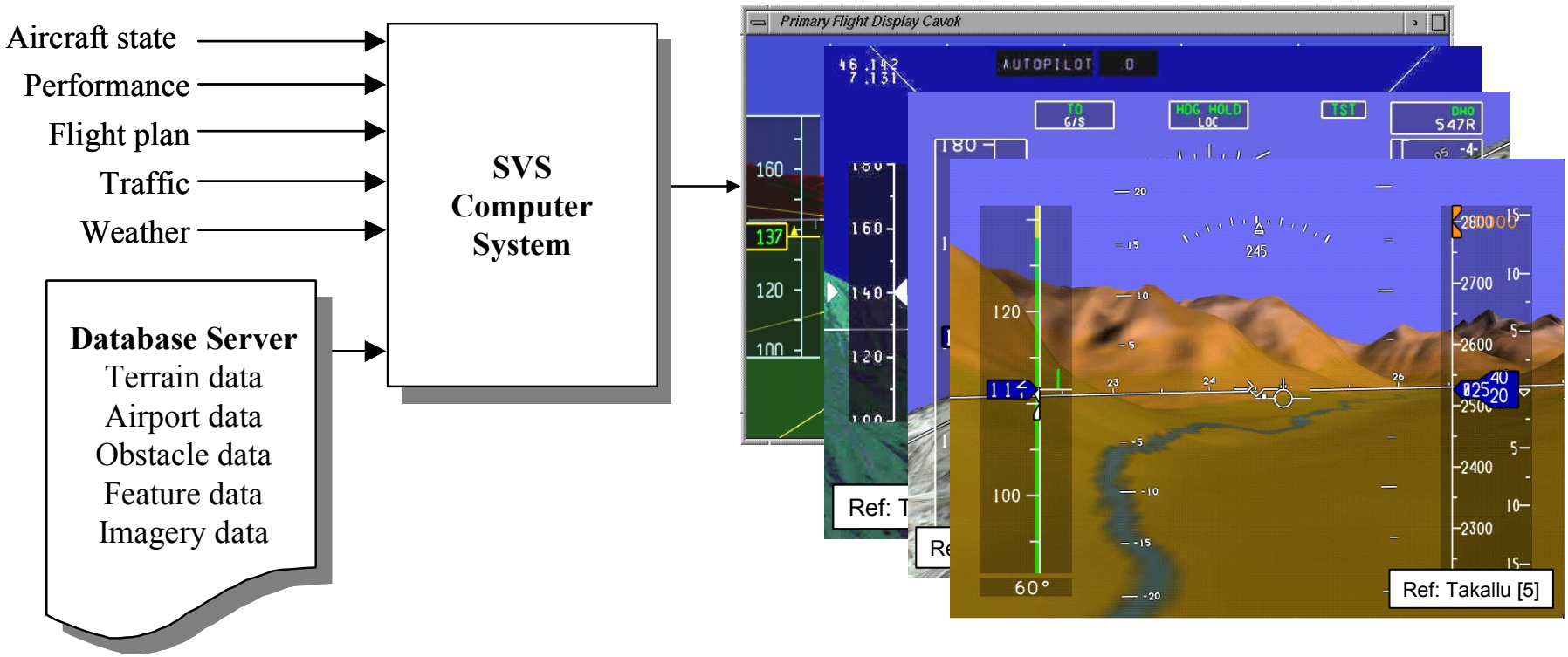
- Minimum Safe Altitude Warning Systems (MSAW)
- Instrument procedure design
- Engine-out procedure analysis
- Training
  - flight simulation
  - mission rehearsal



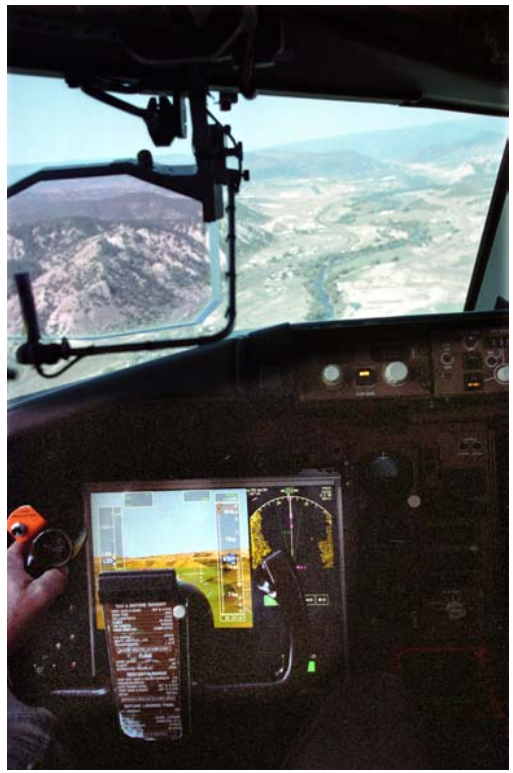
*Ref: RTCA DO-276, EUROCAE ED-119

Synthetic Vision System (SVS)

A system that utilizes positioning/attitude sensors, stored geospatial data, and surveillance data to provide pilots with a view of the external environment.

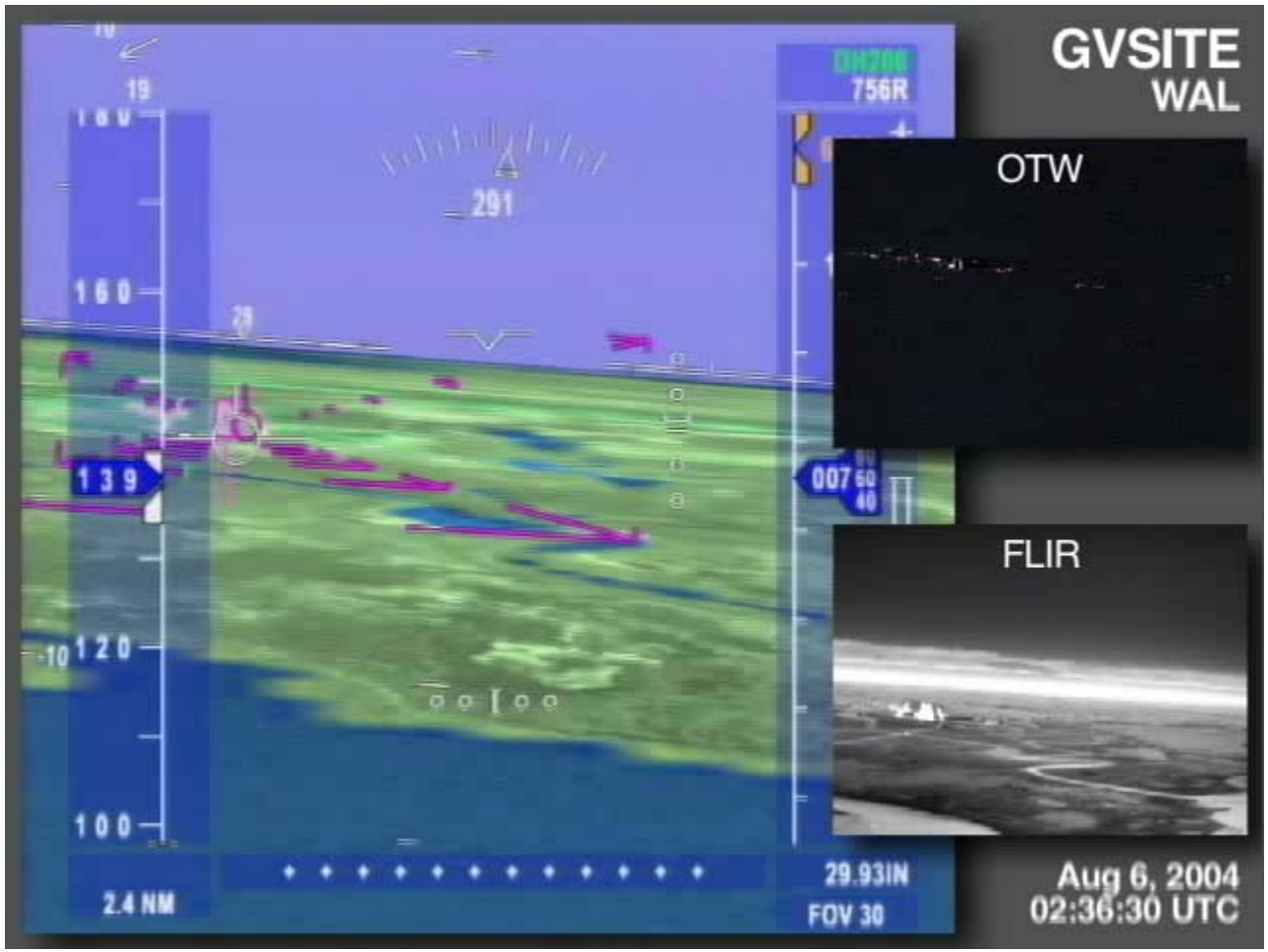


SVS Flight Deck Concepts

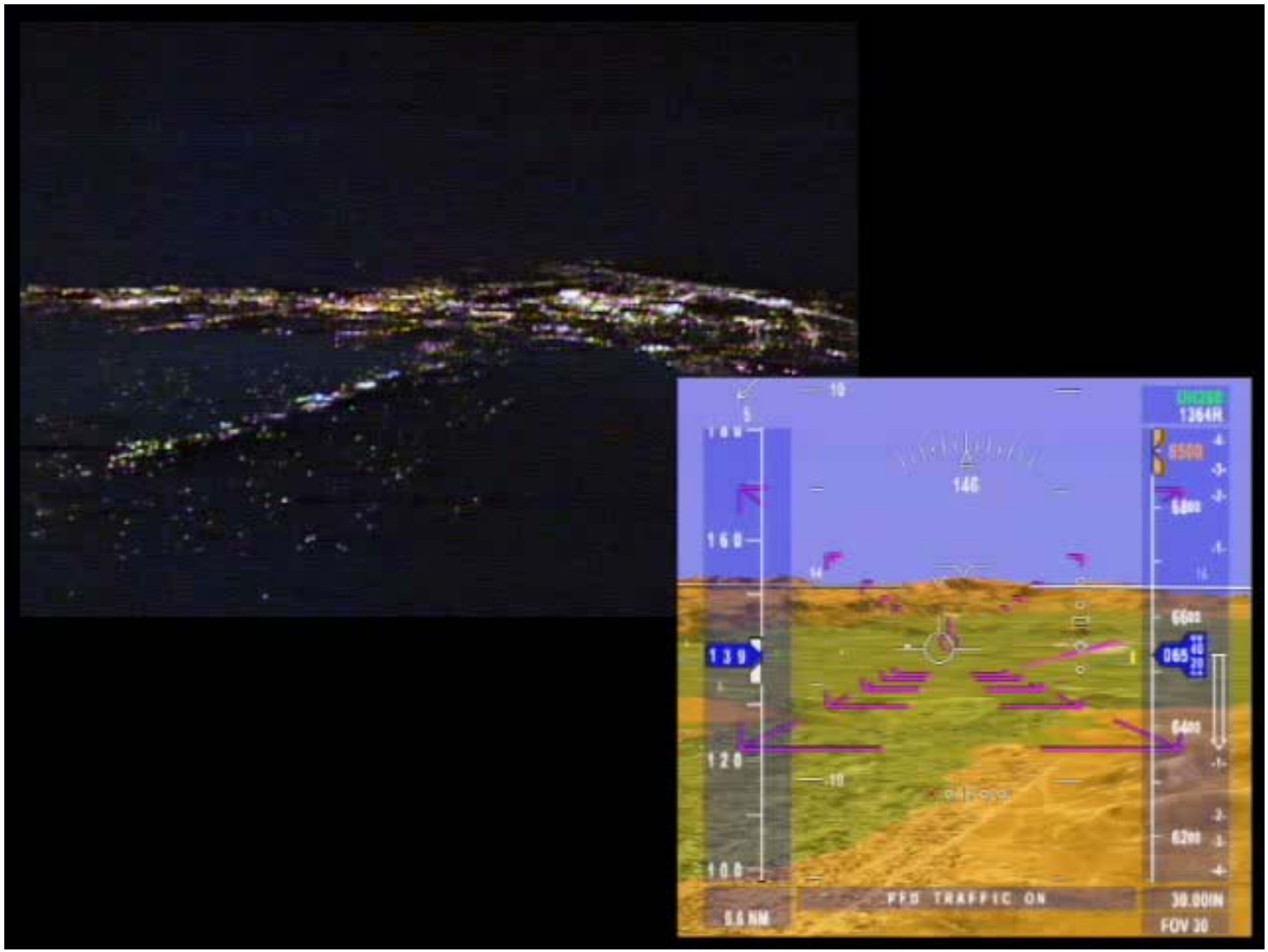


SVS Flight Trials (EGE)

SVS Flight Trials (WAL)



SVS Flight Trials (RNO)



SVS Implementation Status

: Multiple demonstrations on various platforms

: FAA Advisory Circular in final draft

: Chelton product certified

: Others in the works

- Honeywell, Rockwell-Collins, BAE Systems, Universal Avionics

: Data integrators developing infrastructure, processes, and test databases

- Boeing-Jeppesen
- Eurocontrol (EAD)

Aeronautical Database Standards

Quality and Content

: *User Requirements for Aerodrome Mapping Information*, RTCA DO-272, EUROCAE ED-99, October, 2001

: *User Requirements for Terrain and Obstacle Data*, RTCA DO-276, EUROCAE ED-98, December, 2001

: RevA versions to be published this summer (2005)

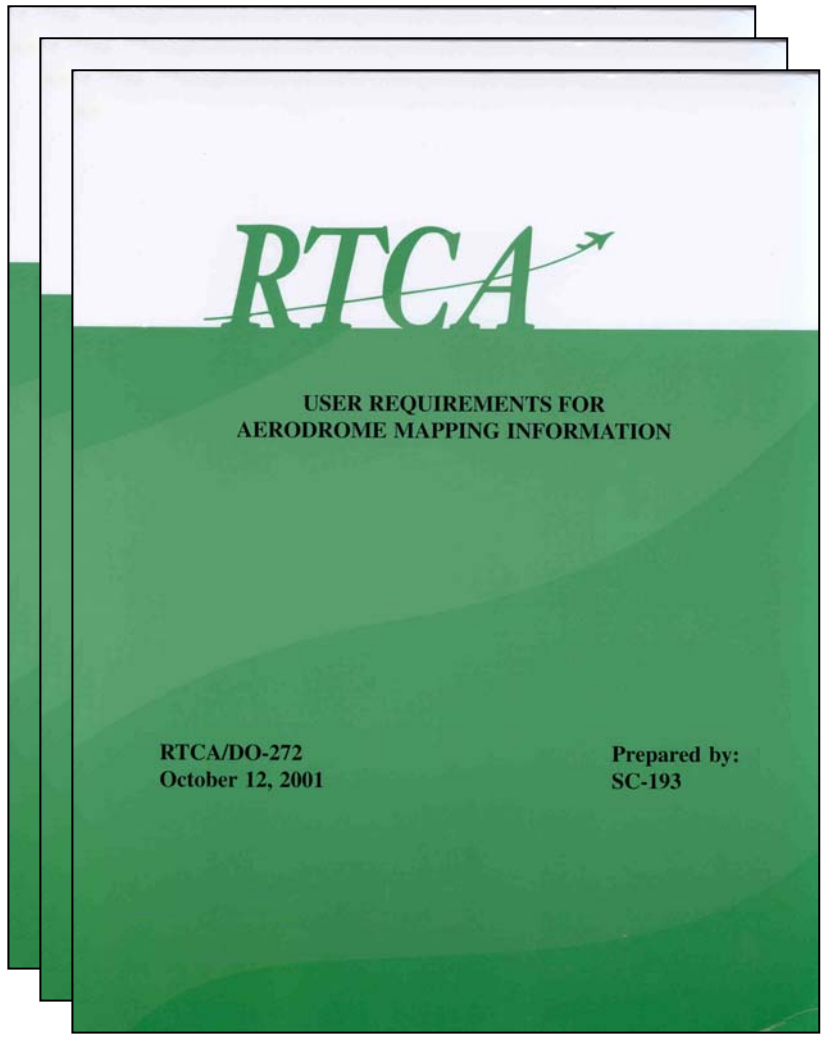
Exchange Model

: *Interchange Standards for Terrain, Obstacle, and Aerodrome Mapping Data*, RTCA DO-291, EUROCAE ED-119, June, 2004

: Based on ISO 19100 series of standards

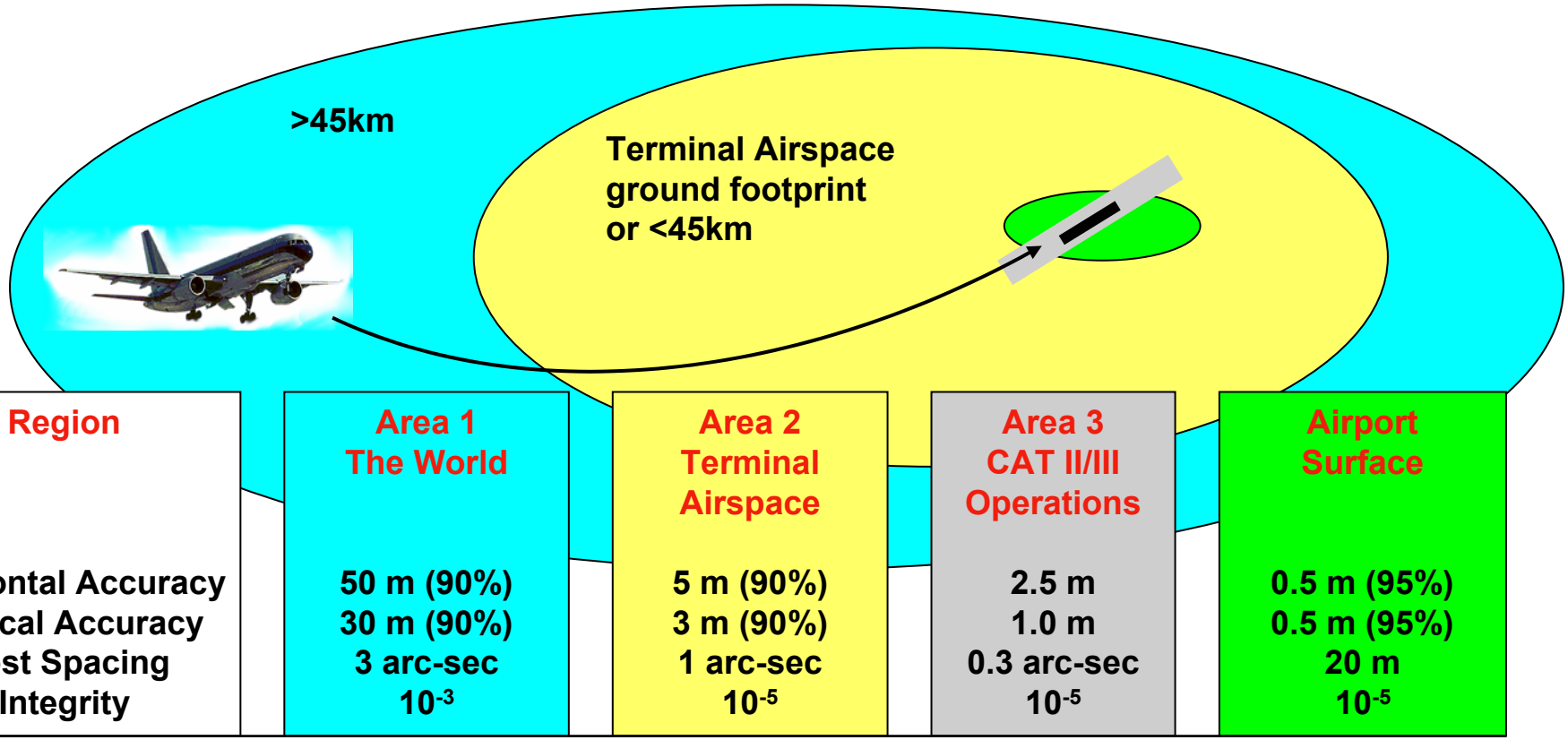
Processing

: *Standards for Processing Aeronautical Data*, RTCA DO-200A, EUROCAE ED-76, September, 1998



www.rtca.org, www.eurocae.org

Terrain Database Requirements*



Region	Area 1 The World	Area 2 Terminal Airspace	Area 3 CAT II/III Operations	Airport Surface
Horizontal Accuracy	50 m (90%)	5 m (90%)	2.5 m	0.5 m (95%)
Vertical Accuracy	30 m (90%)	3 m (90%)	1.0 m	0.5 m (95%)
Post Spacing	3 arc-sec	1 arc-sec	0.3 arc-sec	20 m
Integrity	10^{-3}	10^{-5}	10^{-5}	10^{-5}

Metadata: area of coverage, source identifier, acquisition method, post spacing, reference system, horizontal/vertical accuracy and confidence level, elevation reference, recorded surface, integrity, date/timestamp, surface type (opt), penetration (opt), known variations (opt)

*Ref: RTCA DO-276, EUROCAE ED-119

International Civil Aviation Organization (ICAO)

: RTCA/EUROCAE requirements used as basis to amend existing ICAO requirements for navigation databases to include terrain and obstacle data

: Requires 188 member states (i.e. countries) to provide/maintain terrain and obstacle databases as they do with navigation data today

: Compliance required by...

- 2008 (Area 1 and CAT II/III Area)
- 2010 (Area 2 and Airport Surface)

www.icao.org

SRTM Data Applicability

: RTCA considered SRTM data products to create Area 1 specs
- -Near world-wide coverage
- -Adequate post spacing and quality
- -Consistent data source
- -"Publicly" available

: SRTM technical issues
- -Thinned 3" dataset hides max elev within grid cells
- -Method of filling voids (including V&V) must be established and consistently applied
- -First surface may need land cover map for proper interpretation

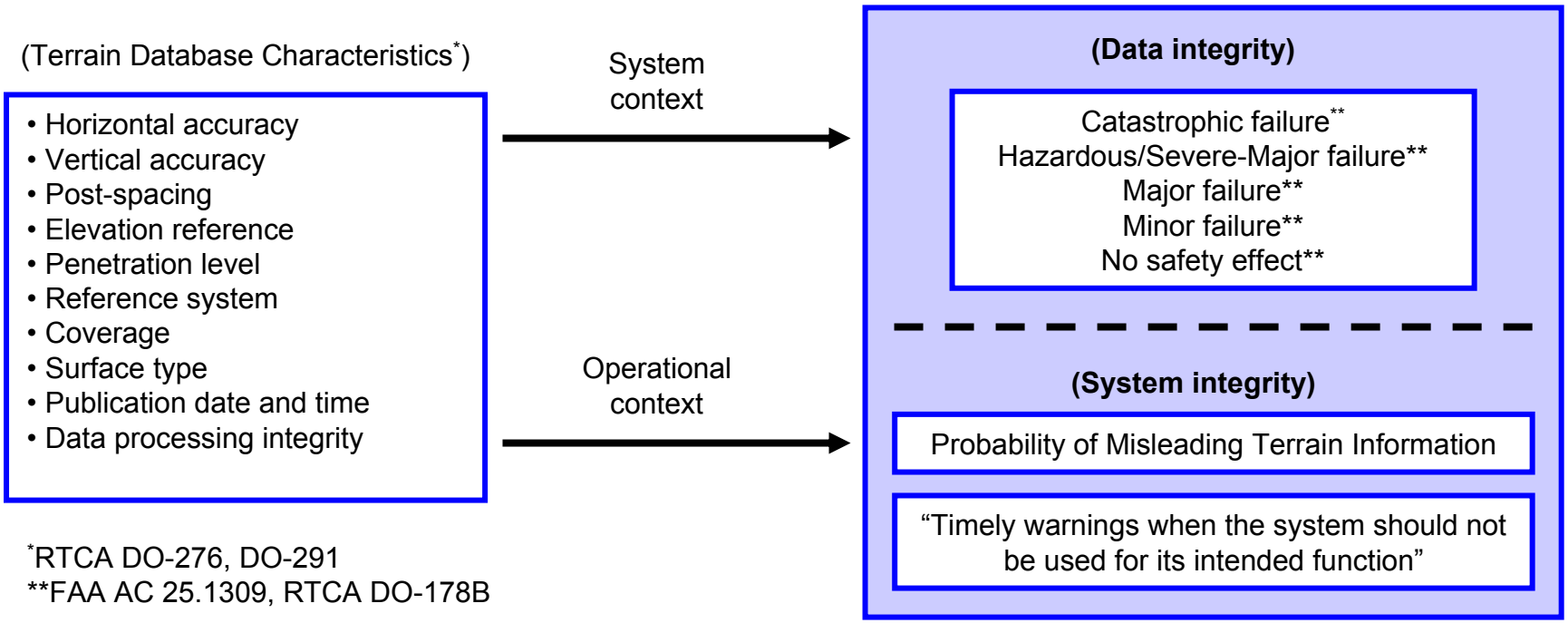
: Other products of use
- -Peaks data; water boundaries; obstacle data
- -Metadata: has data been checked against independent source

: Civil vs Military "political" issue looms…

SRTM data availability issues (restrictions) may need to be overcome for global ICAO requirements to be achievable thereby enabling envisioned aviation safety improvements

Integrity

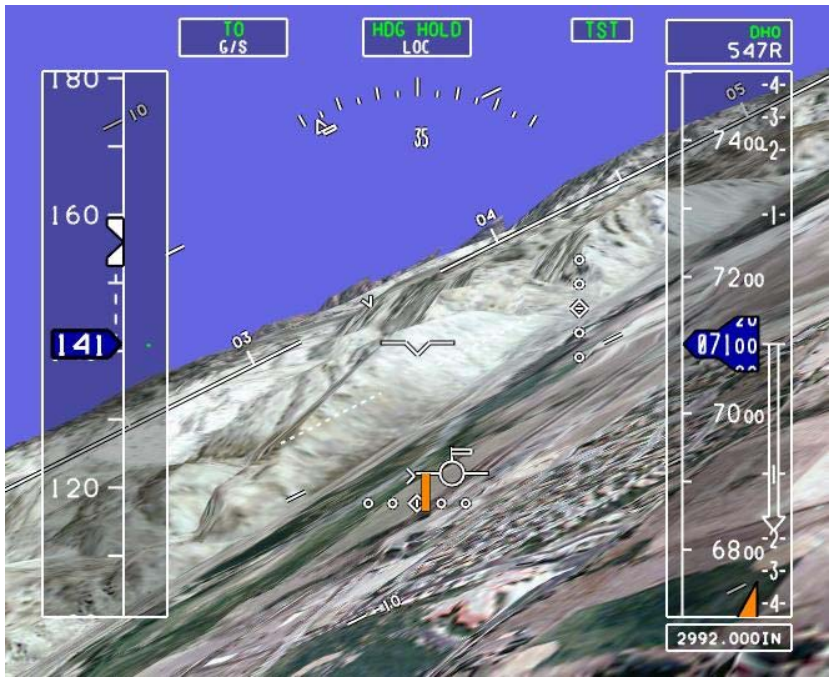
: Integrity is the primary issue facing the use of any data, including SRTM products, in aviation applications.



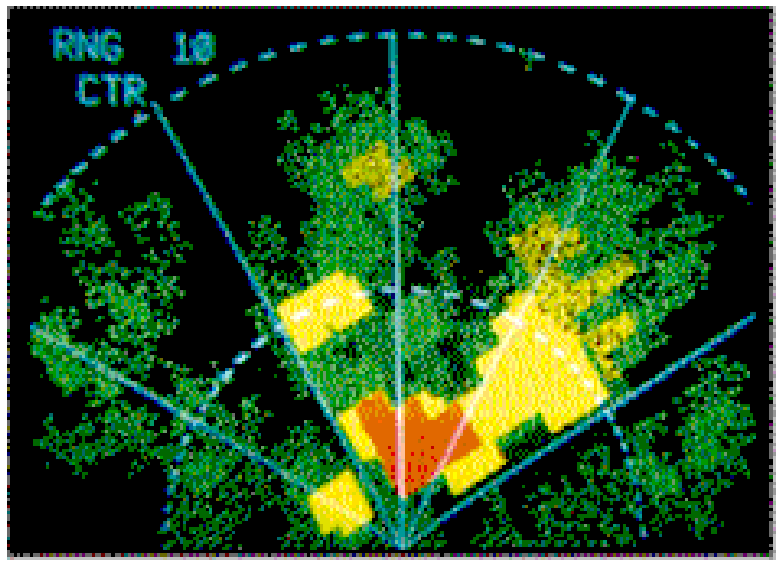
*RTCA DO-276, DO-291
**FAA AC 25.1309, RTCA DO-178B

For example, if you don't leave the ramp, Pr[MTI]=0!

Intended Function Drives Integrity Requirements



SVS displays are intended to replace existing primary flight displays and will be used for navigational purposes (i.e. flight-critical in IMC)



TAWS displays are intended to provide terrain awareness only and are not to be used for navigational purposes (i.e. advisory)

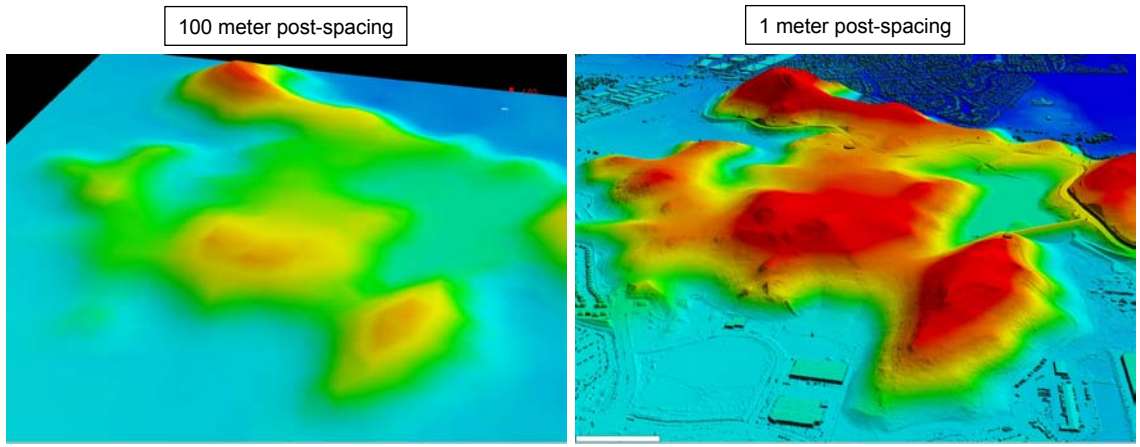
DEM Integrity

How can we get it?

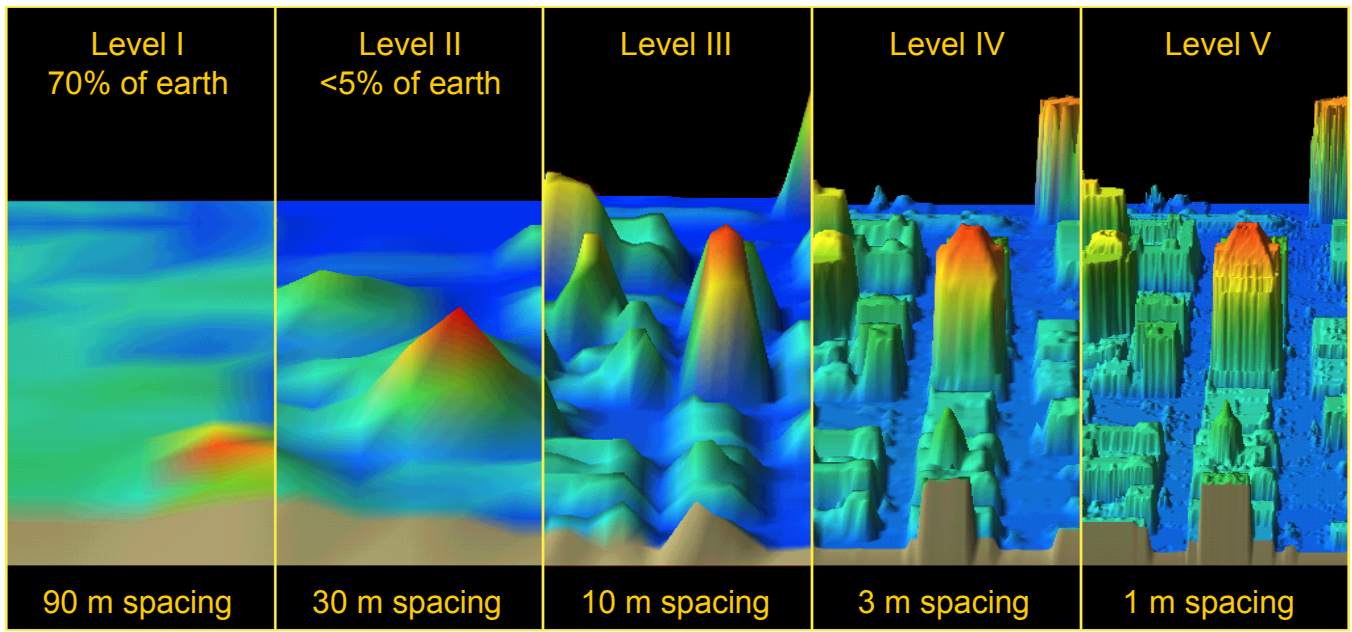
: Quality source data

: Certified life-cycle process

: In-flight monitoring



Source: DFRC ALTM Mission

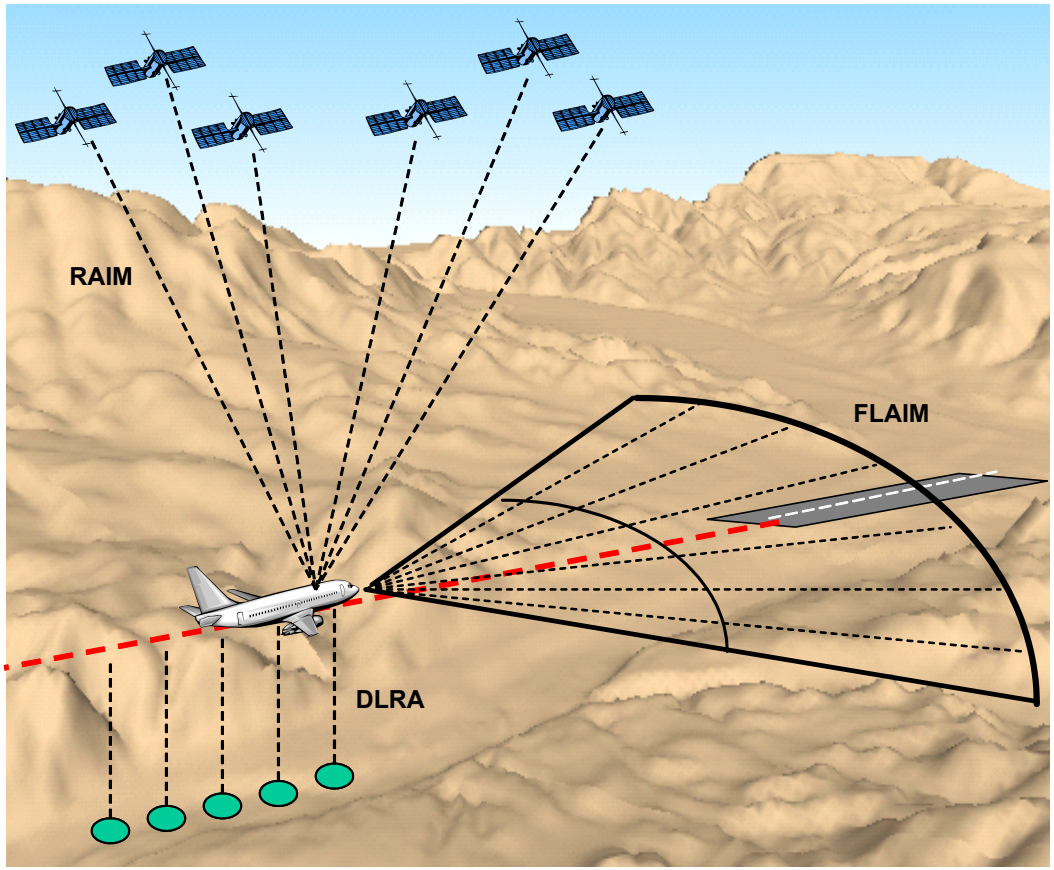


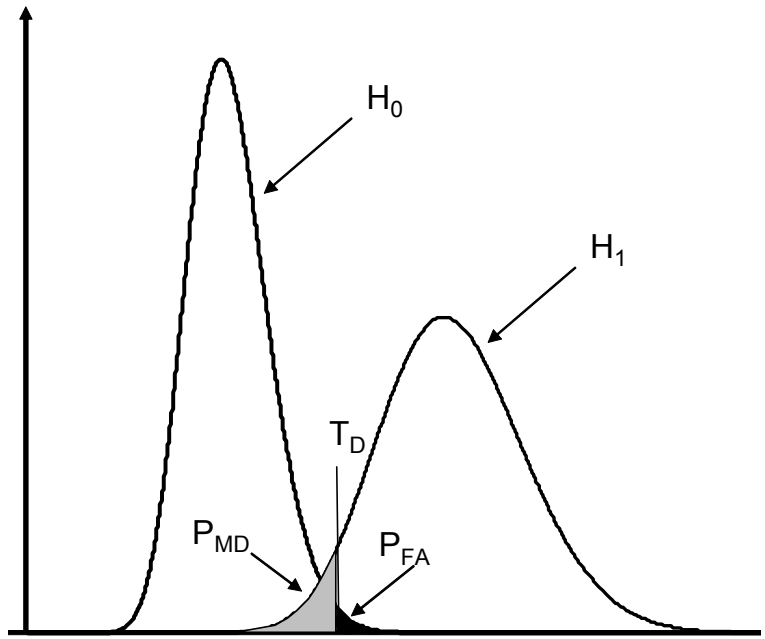
Source: US Army

In-flight Monitoring

: Use sensor measurements to confirm terrain model quality

: When significant differences occur, inform the pilot and/or log for maintenance action





P(loss of integrity) = P(data error leads to MTI) * P(missed detection)

Summary

: Quality terrain models can directly impact the safety of aviation operations

: SVS and TAWS allow pilots to interpret the terrain environment in real-time

: Standards specific to aviation have been published for geospatial data

: SRTM products are expected to be used to meet Area 1 (en-route) requirements

: Data integrity is the biggest open issue
- Driven by “intended function”